Chromosome Numbers in Characeae from the South Pacific[1]

Arland Hotchkiss[2]

ABSTRACT: This study of a total of 18 collections represents the first sampling of chromosome numbers in the charophytes from New Caledonia, Fiji, and Samoa. Chromosome counts were obtained for the first time for material of *Lamprothamnium* (*Chara*) *succinctum,* and the count supports the transfer to the genus *Lamprothamnium.* Chromosome counts consistent with earlier reports are those of 14 for the dioecious taxa included in *Chara corallina* (*Chara australis, Protochara australis, Chara fulgens*) by Wood, and 18 for *Nitella acuminata.* Not in accord with some earlier reports are the counts of 18 for *Nitella hyalina,* 18 for *Nitella pseudoflabellata* (including *N. mathuata*), 18 for *Nitella furcata,* and 28 for *Chara fibrosa.*

The presence of somatic pairing of chromosomes is noted in *Chara fibrosa,* and the extent and importance of polyploidy in the charophytes is recalled.

The extensive collections of charophytes made by Dr. R. D. Wood during the course of an expedition ranging from Australia to New Zealand and islands of the South Pacific in 1960–61 will form an important basis for studies on the Characeae of these regions. As already reported (Wood, 1962*b*) the collections include plant specimens gathered and preserved especially for cytological examination. These the writer was privileged to receive, together with the accompanying field notes and identifications which follow the revision of the group by Wood (1962*a*). This paper, the first in a series to record the chromosome numbers and related cytological findings in the Wood collections, is concerned with the plants from New Caledonia, Fiji, and Samoa, and is concurrent with detailed taxonomic treatments of these plants by Wood (1963, 1965). Although the present paper is complementary in nature no attempt has been made to support all the taxonomic conclusions in Wood's revision of the Characeae.

Plant Materials and Methods

For the cytological studies, fertile plants with growing tips bearing young stages of gametangial development were selected and fixed in the field. In dioecious species only the male plants are required for the young antheridia used in making chromosome counts. Fixation with freshly prepared acetic-alcohol was done in the usual manner. The specimens were then transferred to 70% ethanol and shipped in sealed vials by airmail to Louisville, where they were stored under refrigeration. Chromosome counts were made from mitoses found in squashed preparations of filaments dissected from the antheridia and stained with aceto-orcein. Usually a series of preparations were needed before a count could be determined with certainty. Drawings were made with the aid of a camera lucida.

Four vials of specimens were received from New Caledonia, 12 from Fiji, and 1 from Samoa, each of which yielded chromosome counts. All these specimens and the permanent slides of chromosome preparations made from them are deposited in the Herbarium of the University of Louisville; other parts of these collections are deposited elsewhere (Wood, 1962*b*).

The collection data listed below include the notes supplied by Dr. Wood as to dates, localities, ecology, and collecting numbers. The cytology collection numbers (CYT) were included with the notes and on the cork stoppers of the

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vials sent to Louisville. All these data are included here in an effort to maintain a maximum correlation between our sometimes fragmentary materials and the main collections of complete plants.

COLLECTIONS FROM NEW CALEDONIA

1. *Chara corallina* Klein ex Willd. em. R. D. W.[3]
R. D. Wood 61–6–20–8. June 20, 1961. In c. 4″ of fairly clear water, mud bottom, field pool SE of "Dumbea Barrage Road" c. 2.5 km N of W Coast road New Caledonia. (CYT NC–5.)

2. *Lamprothamnium succinctum* (A. Br. in Asch.) R. D. W.
R. D. Wood 61–6–20–1. June 20, 1961. In c. 8″ of brackish water, fairly turbid, soft mud bottom, SE side about ⅔ way to NE end on Marsh "Hippodrome," Noumea, New Caledonia. (CYT NC–1.)

3. *Lamprothamnium succinctum* (A. Br. in Asch.) R. D. W.
R. D. Wood 61–6–20–4. June 20, 1961. In c. 8″ of brackish, fairly turbid water, soft mud bottom, SE side of marsh c. ⅔ way to NE end, "Hippodrome," Noumea, New Caledonia. (CYT NC–2.)

4. *Nitella hyalina* (DC) Ag.
R. D. Wood 61–6–20–6. June 20, 1961. In c. 4″ of fairly clear water, mud bottom, field pool SE of "Dumbea Barrage Road," c. 2.5 km N of W coast road, New Caledonia. (CYT NC–3.)

FIJI

1. *Chara corallina* Klein ex Willd. em. R. D. W.
R. D. Wood & Vakuru Waibuta 61–6–29–6. June 29, 1961. In c. 6″ of clear water, mud bottom, pool in dry ricefield, W of Nakoroutari Rd., c. 2 mi. S of Nakama Rd., probably c. 5 mi. S of Labasa, Vanua Levu, Fiji. (CYT Fiji–17.) (In collection primarily of *C. fibrosa*.)

2. *Chara corallina* Klein ex Willd. em. R. D. W.
R. D. Wood 61–7–1–1. July 1, 1961. Abundant in 1–2 ft. of fairly clear water, mud bottom, large pool c. 100 ft. SE of Loa Rd. c. 26 mi. E of Savusavu airport, Cakadrove Peninsula, Vanua Levu, Fiji (at culvert L284). (CYT Fiji–20.)

3. *Chara corallina* Klein ex Willd. em. R. D. W.
R. D. Wood & Vakuru Waibuta 61–6–29–1. June 29, 1961. In c. 3″ of clear water, mud bottom, pool in drained ricefield W of Nakoroutari Rd., c. 150 ft. W of culvert marker K33, probably c. 5 mi. S of Labasa, Vanua Levu, Fiji. (CYT Fiji–16.)

4. *Chara fibrosa* Ag. ex Bruz.
R. D. Wood 61–6–9–1. June 9, 1961. In c. 6″ of fairly clear water, mud bottom, pond in marsh, N side of Queen's Road, c. 1 mi. W of Sigatoka Hotel, Viti Levu, Fiji. (CYT Fiji–1.)

5. *Chara fibrosa* Ag. ex Bruz.
R. D. Wood 61–6–28–1. June 28, 1961. Large mass in c. 6″ of clear, fresh water, black muck bottom, small ditch pool on W side of Natovi-Korovou Rd., c. 13 mi. N of Korovou, Viti Levu, Fiji. (CYT Fiji–15.)

6. *Nitella acuminata* A. Br. ex Wallm.
R. D. Wood 61–6–25–1. June 25, 1961. In 3–4″ of clear water, mud bottom, wet field N of road, c. ¼ mi. N of Navua Hotel, Navua, Fiji (c. 28 mi. W of Suva). (CYT Fiji–10.)

7. *Nitella acuminata* A. Br. ex Wallm.
R. D. Wood & S. Pillay 61–6–26–3. June 26, 1961. In c. 12″ of fairly turbid water, mud bottom, amid water lilies, in the western of the two large lily ponds on the plain below Adi Cakabou School, Sawani (c. 18 mi. N of Suva), Fiji. (CYT Fiji–14.)

8. *Nitella pseudoflabellata* A. Br. em., glomerate form.
R. D. Wood & Bernard Vunibobo 61–6–13–1. June 13, 1961. In c. 3″ of clear flowing water, mud bottom, drainage ditch in village green, Nacobo Koro, c. 6.4 mi. S of Levuka, Ovalau, Fiji. (CYT Fiji–2.)

9. *Nitella pseudoflabellata* A. Br. em., fruticose form.
R. D. Wood 61–6–25–6. June 25, 1961. In c. 8″ of clear, fresh water, fairly firm mud bottom, pool c. 50 ft. behind beach c. 500 yd. S of jetty, Naitonitoni, Viti Levu, Fiji (c. 31 mi. W of Suva). (CYT Fiji–11.)

10. *Nitella pseudoflabellata* A. Br. em., tiny form.
R. D. Wood & Vakuru Waibuta 61–6–29–6. June 29, 1961. In c. 6″ of clear water, mud bottom, pool in dry ricefield, W. of Nakoroutari

[3] em. Wood, 1962, to include both dioecious and monoecious forms, thus uniting *C. australis* and *C. corallina* in one taxon.

Rd., c. 2 mi. S of Nakama Rd., probably c. 5 mi. S of Labasa, Vanua Levu, Fiji. (CYT Fiji–17.)

11. *Nitella pseudoflabellata* A. Br. em., diffuse form.

R. D. Wood & Vakuru Waibuta 61–6–29–8. June 29, 1961. In c. 6″ of clear water, muck bottom, pool in dry ricefield, W of Nakoroutari Rd., c. 2 mi. S of Nakama Rd., probably c. 5 mi. S of Labasa, Vanua Levu, Fiji. (CYT Fiji–18.)

12. *Nitella pseudoflabellata* A. Br. em., var. *mathuata* (T.F.A.) R.D.W.

R. D. Wood & Vakuru Waibuta 61–6–30–5. June 30, 1961. Abundant in c. 3″ of clear water, sandy mud, overflow stream from pool in creek at place known as "Vuniwesi" in valley c. ¼ way around S side of island from NE end, Mathuata-i-wai Island, Vanua Levu, Fiji. (CYT Fiji–20X.)

13. *Nitella pseudoflabellata* (duplicate of CYT Fiji–20X.)

SAMOA

1. *Nitella furcata* (Roxb. ex Bruz.) Ag. var. *sieberi* (A. Br.) R. D. W.

R. D. Wood, Ed Tia'i & Esekia Sei'a 61–8–1–1. August 1, 1961. (CYT Samoa–1.)

CHROMOSOME NUMBERS

The chromosome counts together with the collection numbers from this study are listed in Table 1 in the same sequence followed in listing the collection data. The numbers are gametic numbers taken from mitoses in the antheridial filaments prior to formation of the sperm. Illustrations of the chromosomes of each species are shown in Figures 1 and 2.

DISCUSSION AND CONCLUSIONS

As is to be expected some of the chromosome numbers recorded here represent unreported species, while others either confirm previous counts or are at variance with those of previously published numbers. There is a total of five new counts.

In the revision of Wood (1962*a*) many well-known species have been reduced to lower taxa. Notes connecting the revision names with the older usage are provided in the following discussion of individual species and collections.

TABLE 1

CHROMOSOME NUMBERS IN CHAROPHYTES FROM THE SOUTH PACIFIC
(By A. and D. Hotchkiss)

SPECIES (*sensu* Wood, 1962*a*)	*n*	COLLECTION NUMBERS	FIGURE
NEW CALEDONIA			
1. *Chara corallina*	14	61–6–20–8 (CYT NC–5)	1*a*
2. *Lamprothamnium succinctum*	42	61–6–20–1 (CYT NC–1)	1*e*
3. *L. succinctum*	42	61–6–20–4 (CYT NC–2)	1*f*
4. *Nitella hyalina*	18	61–6–20–6 (CYT NC–3)	1*j*
FIJI			
1. *Chara corallina*	14	61–6–29–6 (CYT Fiji–17) *	1*b*
2. *C. corallina*	14	61–7–1–1 (CYT Fiji–20)	1*c*
3. *C. corallina*	14	61–6–29–1 (CYT Fiji–16)	1*d*
4. *C. fibrosa*	28	61–6–9–1 (CYT Fiji–1)	1*g*
5. *C. fibrosa*	28	61–6–28–1 (CYT Fiji–15)	1*h, i*
6. *Nitella acuminata*	18	61–6–25–1 (CYT Fiji–10)	2*a, b*
7. *N. acuminata*	18	61–6–26–3 (CYT Fiji–14)	2*c*
8. *N. pseudoflabellata*	18	61–6–13–1 (CYT Fiji–2)	2*d, e*
9. *N. pseudoflabellata*	18	61–6–25–6 (CYT Fiji–11)	2*f, g*
10. *N. pseudoflabellata*	18	61–6–29–6 (CYT Fiji–17) *	2*h*
11. *N. pseudoflabellata*	18	61–6–29–8 (CYT Fiji–18)	2*i*
12. *N. pseudoflabellata*	18	61–6–30–5 (CYT Fiji–20X)	2*j*
13. *N. pseudoflabellata*	18	61–6–30–5 (CYT Fiji–20X duplicate)	
SAMOA			
1. *Nitella furcata*	18	61–8–1–1 (CYT Samoa–1)	1*k*

* A mixed collection.

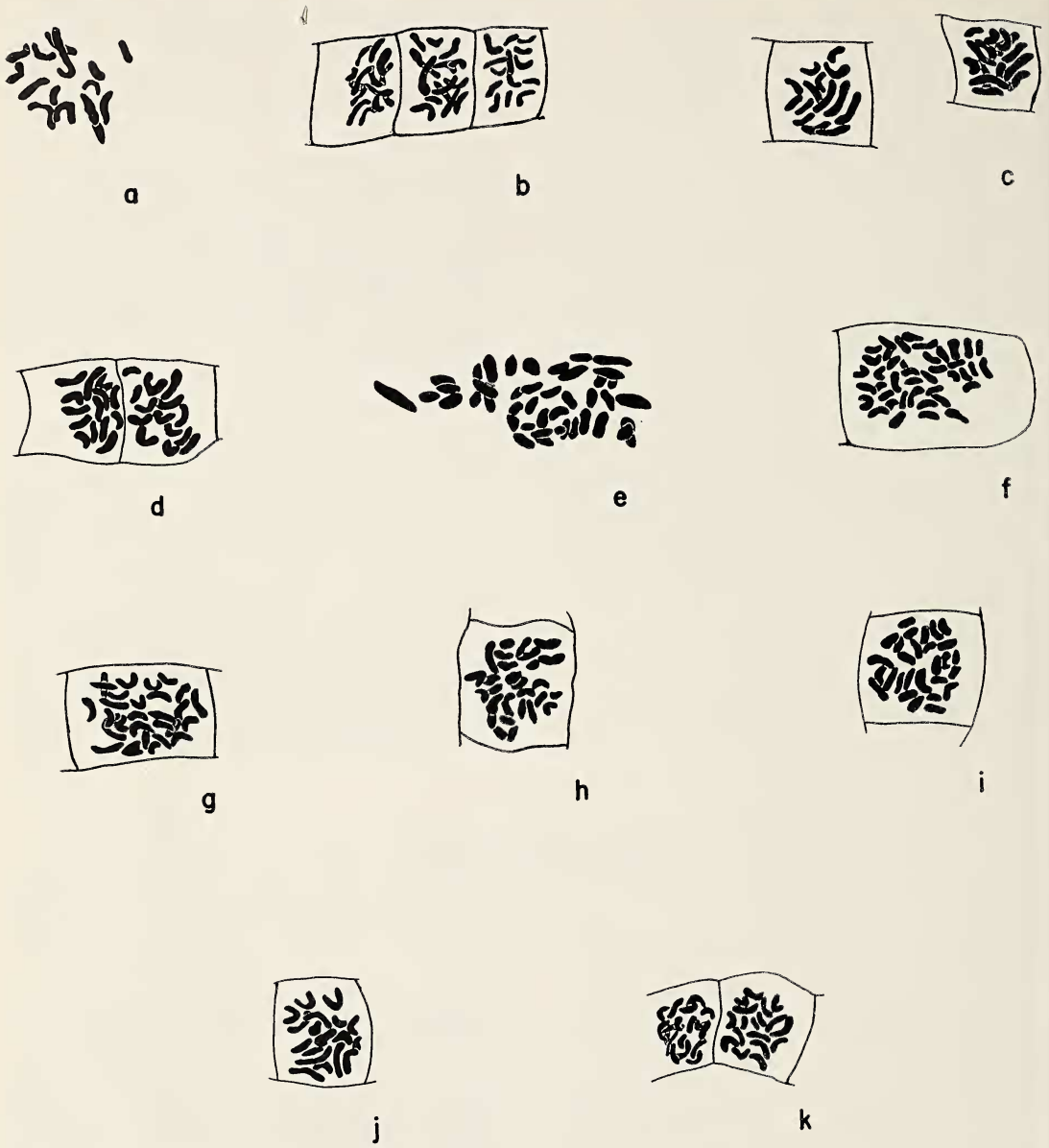

FIG. 1. Metaphase chromosomes in antheridial filaments of charophytes from the South Pacific. *a-d, Chara corallina* (sensu Wood, 1962*a*); *e-f, Lamprothamnium succinctum; g-i, Chara fibrosa; j, Nitella hyalina; k, Nitella furcata.* (Camera lucida drawings, all X 900.)

New Caledonia

1. *Chara corallina* (CYT NC–5). Figure 1.

Plants ecorticate, dioecious, with basal gametangia, have the combination of characters of *Chara australis;* the inflated axes and generally lacking or reduced lateral appendages more narrowly suggest *Protochara australis.* In correspondence Wood notes,

"CYT 5 . . . I find to be *Chara corallina* (dioecious strain)—the *C. australis* of earlier workers, in part). You have *'Protochara australis,'* but the specimens I have from New Caledonia are not nearly so inflated as the ones I've seen from Australia."

The chromosome number 14 is to be expected

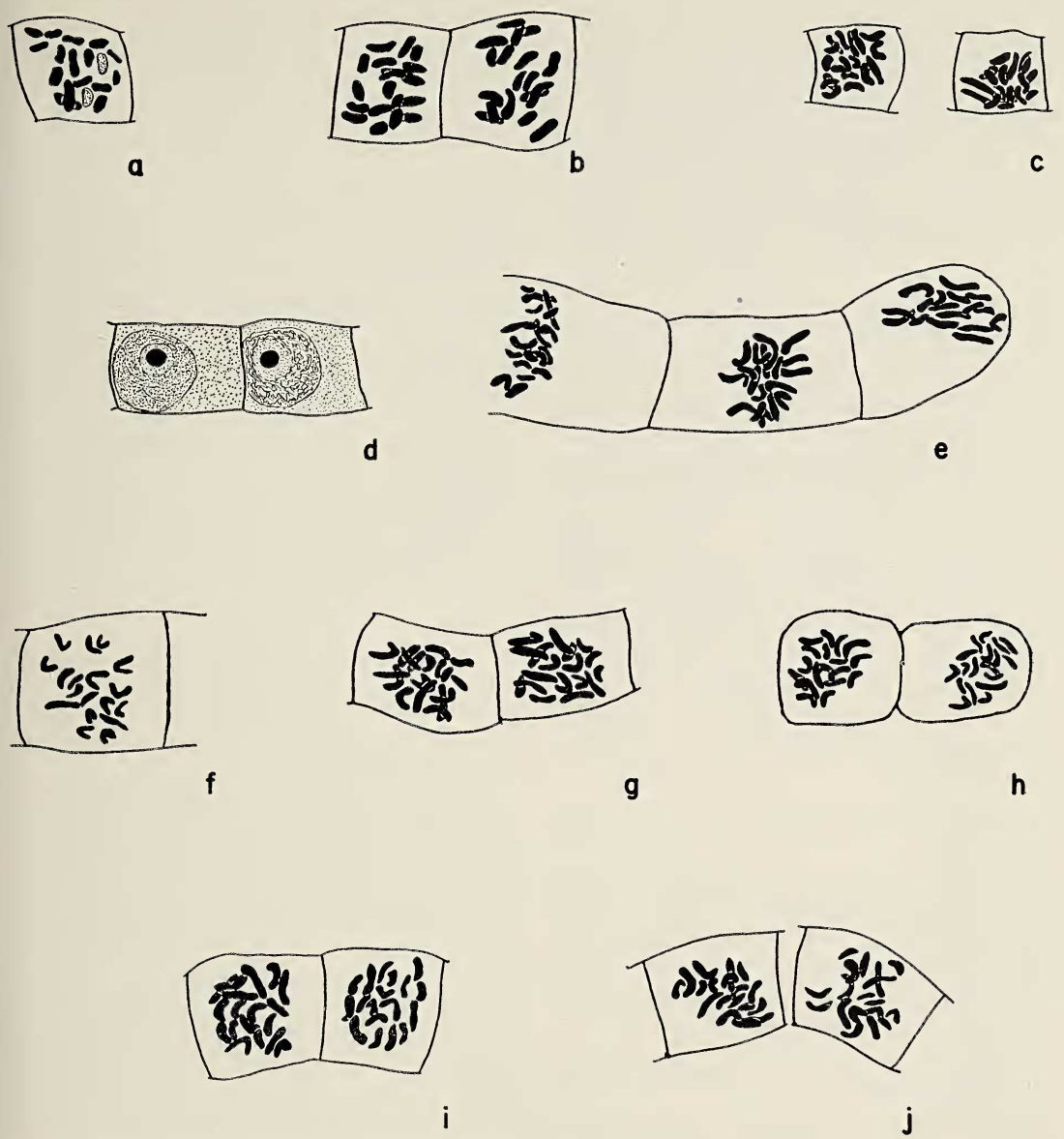

FIG. 2. Chromosomes in antheridial filaments of charophytes from the South Pacific. *a-c, Nitella acuminata* metaphase; *d-j, Nitella pseudoflabellata; d,* interphase, *e-j,* metaphase. (Camera lucida drawings, all X 900.)

in all members of the Haplostephanae-ecorticatae; the count recorded here confirms the previous counts of 14 in the dioecious *Chara* (*Protochara*) *australis* from Australia (MacDonald and Hotchkiss, 1955).

2–3. *Lamprothamnium succinctum* (CYT NC–1 and 2). Figure 1*e, f*.

The present count of 42 chromosomes is a first report for this species. The high number of 42 agrees generally with another count for this genus, that of Lindenbein (1927) which was ca. 50 for *Lamprothamnium papulosum* (Wallr.) J. Groves. The number and general configuration of the chromosomes lend support to Wood's (1962*a*: 14) transfer of *C. succinctum* to the genus *Lamprothamnium*.

4. *Nitella hyalina* (CYT NC–3). Figure 1*j*.

The report of 18 chromosomes here confirms our unpublished counts of 18 chromosomes in this species from North Carolina and Mexico. A count of 16 was proposed by Gillet (1959) and the numbers 12, 14, 18 have all been reported by Sato (1959), but we have seen no tendency towards such variations in *Nitella hyalina.*

Fiji

1–2. *Chara corallina* (CYT Fiji–17 and 20). Figure 1*b, c.*

Both specimens are ecorticate, dioecious, with basal gametangia and lateral appendages and fall in the earlier category of *Chara australis.* The chromosome count of 14 confirms the counts for this species (MacDonald and Hotchkiss, 1955).

3. *Chara corallina* (CYT Fiji–16). Figure 1*d.*

A lack of gametangia at the base of the branchlets in our material suggested the characters of *Chara fulgens* Fil. in Asch.[4] except for the geminate and not solitary gametangia. This combination of characters fills one of the blank spaces in the table of *Homologous Variations in the Haplostephanae-ecorticatae of Chara* of Zaneveld (1940).

4–5. *Chara fibrosa* (CYT Fiji–1 and 15). Figure 1*g, h, i.*

Following the treatment of Zaneveld (1940), Wood notes that this includes *Chara gymnopitys* A. Br. of earlier authors. A count of 28 chromosomes is a first report for this species and is to be compared with our unpublished counts of 42 for this species from North Carolina.

6–7. *Nitella acuminata* (CYT Fiji–10 and 14). Figure 2*a, b, c.*

Wood (1965) recognizes a dendroid and a lax ecad; No. 14 is the dendroid and No. 10 is the lax variant. They seem to overlap typical var. *acuminata.* The chromosomes of *N. acuminata* are somewhat similar in form to those of *N. pseudoflabellata,* but these two species can be separated on the basis of chromosome form. Counts of 18 have been reported previously for *N. acuminata* var. *subglomerata* by Hotchkiss (1958), Imahori and Kato (1961).

8–13. *Nitella pseudoflabellata* (CYT Fiji–2, 11, 17, 18, 20X). Figure 2*d–j.*

Wood (1965) detects six ecads or forms and provides noncommittal names. They include (1) glomerate (*glomerata*), (2) diffuse (*diffusa*), (3) mathuate (var. *mathuata,* olim *N. muthnatae*), (4) elongate (*elongata*), (5) bushy (*fruticosa*), and (6) tiny (*minima*). CYT Fiji–2 is the glomerate, CYT Fiji–11 is the bushy, CYT Fiji–17 is the tiny, CYT Fiji–18 is the diffuse, and CYT Fiji–20X is the mathuate variant.

The only record of a chromosome count in *N. pseudoflabellata* is a 24 reported from Japan (Imahori and Kato, 1961). Although an expected number in *Nitella,* reports of 24 chromosomes have been surprisingly few.

Samoa

1. *Nitella furcata* (CYT Samoa–1). Figure 1*k.*

A count of 18 chromosomes in this species from Samoa is at variance with a report of 24 (and 48) chromosomes by Imahori and Kato (1961) from Japan.

It is noted again that the number of 14 chromosomes is the smallest yet found for any species of *Chara* and that the dioecious species reported here have this number. The correlation between the dioecious condition of sex distribution and low chromosome number (Hotchkiss, 1958) continues to hold, but its significance in relationships in the Haplostephanae-ecorticatae (Section Charopsis of Wood's revision) is obscured by finding the same number in all species of this group, whether monoecious or dioecious, studied thus far.

In the chromosome complements of charophytes, pairs of chromosomes of similar length and form are often seen. In these cases, and as noted in the present study in *Chara fibrosa* (Fig. 1*h, i*), there seems to be more than a chance positioning of homologous chromosomes, suggesting a high degree of somatic pairing. The common appearance of chromosomes in multiples of 6 and 9 (in series of *Nitella* species), and in multiples of 14 (in species of *Chara*), indicates the extent and importance of polyploidy in this group of "lower" plants. Additional cyto-

[4] Wood (correspondence in 1963) includes *C. fulgens* in *C. corallina;* in Fiji he reports the occurrence or absence of basal oogonia to be sporadic in otherwise identical specimens, which further confirms his opinion.

logical features of note include the usual interphase nuclei with nucleoli shown in Figure 2*d* (*Nitella pseudoflabellata*), and a pair of "gray," lightly stained chromosomes apparently lagging in development in *Nitella acuminata* (Fig. 2*a*).

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